

# Final Project Report

**Project Identification Number:** B231      **FY:**

**Project Title:** Optimal Planning of D&D Projects via Simulation Based Design Optimization

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**Project Title:** "Optimal Planning of D&D Projects via Simulation Based Optimization "

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## **Abstract:**

The simulation-based "Decontamination, Decommissioning and Remediation Optimal Planning System (DDROPS)" was developed to help plan Decontamination and Decommissioning (D&D) activities of facilities. It incorporates solid geometric modeling (ProEngineer) and optimization techniques to help identify locations for segmenting contaminated materials (pipes, pumps, valves, tanks, etc.), to help determine packaging locations to attain improved packaging densities within waste boxes, and to minimize radiation exposure to D&D workers. A model of an actual D&D site was created and used to test the optimal segmentation algorithm. The resulting segmented components were then packaged into containers. This tool can be used to minimize the number of cuts, minimize number of waste boxes, improve packaging densities, minimize worker radiation exposure, etc. Reports can be generated detailing the location of cuts to be made and to provide images of the facility for historical purposes. Parts can be color coded to show radiological properties. Physical properties can be defined or calculated.

## **FY98 Technical Objectives:**

- Develop the ability to accurately model three-dimensional sites for D&D planning with ProEngineer. Assign mass property and radiation level data to individual components in the 3D model.
- Perform flythroughs of 3D site models to gain a better understanding of the D&D planning problem. Visualize the model with colors representing levels of radiation for individual components.
- Determine the optimal number and location of cuts with respect to length, mass properties, radiation.
- Package segmented items (pipes, pumps, valves, tanks, etc.) into waste with the model.
- Record onto videotape showing the 3D modeling, optimal cutting, and packaging sequences.
- Select an actual D&D facility as a test case to model, segment, and package.
- Develop a business plan for the "harvesting" of this technology.

## **FY98 Technical Accomplishments:**

A simulation-based capability was developed with the ProEngineer solid modeling software. The tools are used to create realistic three-dimensional models of facilities for D&D planning. One may assign mass property and radiation level data to individual components in the 3D model. The capability to determine the minimum number and location of cuts of the facility's pipes was developed and tested. Criteria that may be considered for cut locations are waste box dimensions, mass properties, and radiation levels. The ability to perform flythroughs of the 3D site models was demonstrated. The ability to produce a videotape recording all activities performed on the workstation was shown.

The ability to package segmented items (pipes, elbows, pumps, valves, tanks, etc.) into waste containers via the simulation-based model was demonstrated with ProEngineer. With

judicious placement of the individual components into waste container models, the waste volume density can be improved while radiation exposure to workers is reduced.

An actual facility at the INEEL site was chosen, modeled, segmented and packaged with the above capabilities. The site chosen was the Central Facility Old Sewage Treatment Plant (CF691). Information to complete the realistic model was obtained from old drawings and photographs. Figure 1 shows a representative image of the drawing available. Figure 2 shows a 2D projection drawing of the ProEngineer model. Figure 3 shows a photograph of some of the components in the facility. Figure 4 shows a close-up view of the ProEngineer model. The different colors represent different levels of radiation, red being high and blue being low. Figure 5 shows a view of the complete facility model. Figure 6 shows the components after being packaged into nine containers.

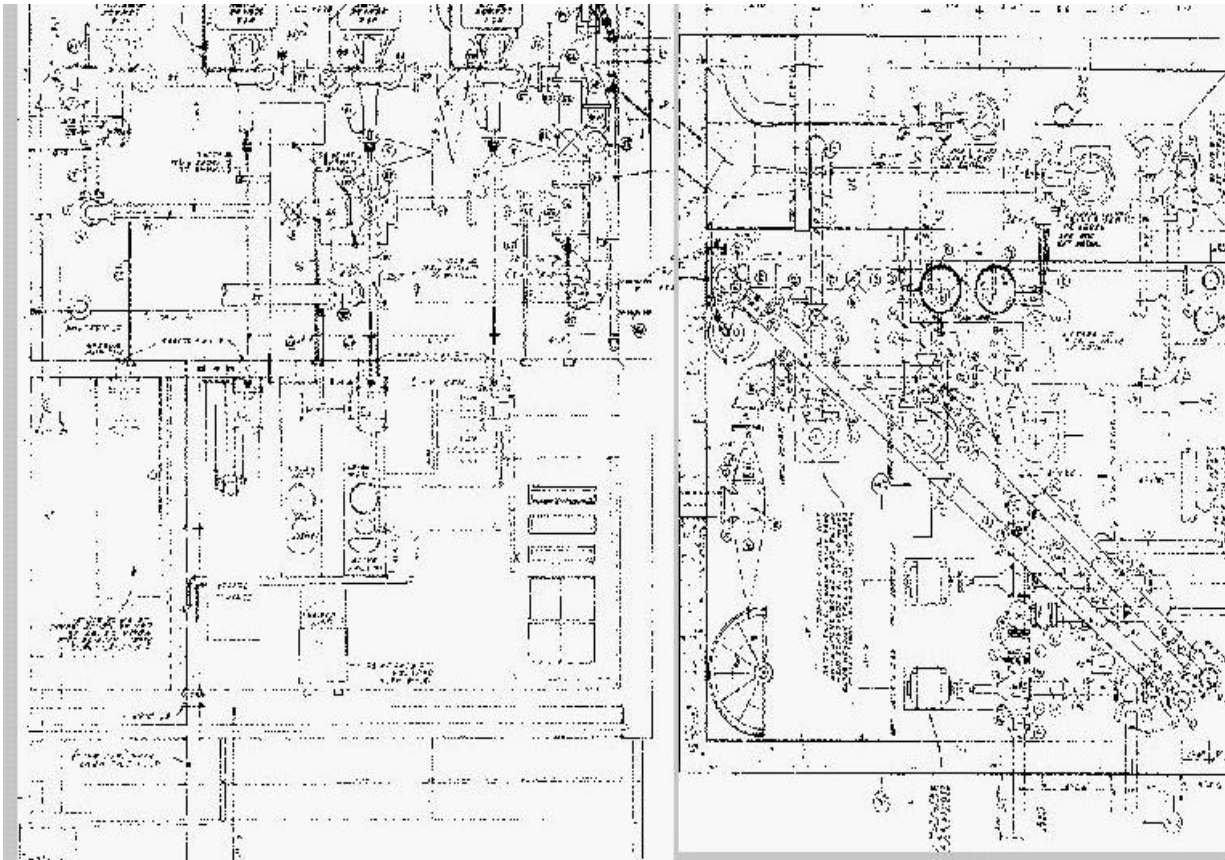
### **New Or Increased Technical Capability at INEEL:**

All of the capabilities discussed above have been created under this LDRD. The overall DDROPS program and capabilities enhances INEEL's recognized lead in D&D technologies.

### **Business Development Opportunities:**

- A LMITCO Patent Application on this technology was filed in January 1998. It is LIT-PI-327.
- A Business Plan was developed that defines how to move DDROPS into the commercial market.  
This includes an assessment of the D&D market, a review of competitive technologies (i.e. baseline and emerging), potential strategic partners, and financial requirements.
- Various aspects of this technology are at levels of maturity where Project funding is being sought.
- Direct funding for FY99 is anticipated to apply this technology to an INEEL D&D activity for the Large Scale Demonstration Program (this is also a DOE EM-50 project).
- Direct funding for FY99 may also come from the Accelerated Technology Deployment Initiative (cost saving technologies) to DOE EM-50.
- A proposal has been submitted to the LMITCO Pollution Prevention Program that would take actual INEEL facilities and demonstrate volume reduction of packaged waste.
- A proposal is being developed for submittal to FETC in the Robotics Cross Cutting technology area for development of a robotic sorting table to package segmented waste into containers.
- Additional marketing activities and opportunities are listed here.
- We have presented DDROPS to government (DOE, NRC) and commercial D&D entities at the X-Change '97 D&D Marketplace. The INEEL had a booth at the trade show. 1-4 December 1997. Miami, FL.
- We have presented DDROPS at a training course sponsored by the International Atomic Energy Agency on Decommissioning of Research Reactors and Other Small Nuclear Facilities at Argonne East, IL. 23-26 March 1998.
- A memorandum of agreement between FETC, the nuclear power industry, Florida International University, and Argonne National Lab was created to develop better technologies for D&D of commercial power plants. These parties have expressed interest in this technology.
- DDROPS was discussed with Larry Boing of ANL-E D&D organization at his request. They are interested in investigating incorporating our technology with their package for use in the DOE, ANL-E, Florida International University, and Nuclear Power Consortium.
- We had two booths at the Spectrum '98 D&D trade show in Denver, CO on Sept. 13-17, 1998. DDROPS was discussed with many people with the Large Scale Demonstration Project, and the Accelerated Site Technology Deployment Project. Color photos of DDROPS were shown in the booth's backdrop.
- We are contacting commercial D&D contractors, such as BNFL, Parsons, TLC Engineering, Bechtel, etc.
- We have submitted another article in FY98 to the Waste Management '99 Conference (Tuscoll, AZ). We will submit at least one more conference presentation or journal article.

- We feel that there are literally hundreds of opportunities to market the technology and to provide services for optimal D&D planning. The current estimate for stored waste is \$500 (five hundred) per cubic foot. Commercial and government entities are searching earnestly for cost effective ways to reduce the total cost of waste processing and storage. The application of this technology to help reduce waste volume will save the industry millions of dollars.



**Figure 1. As-built Prints**

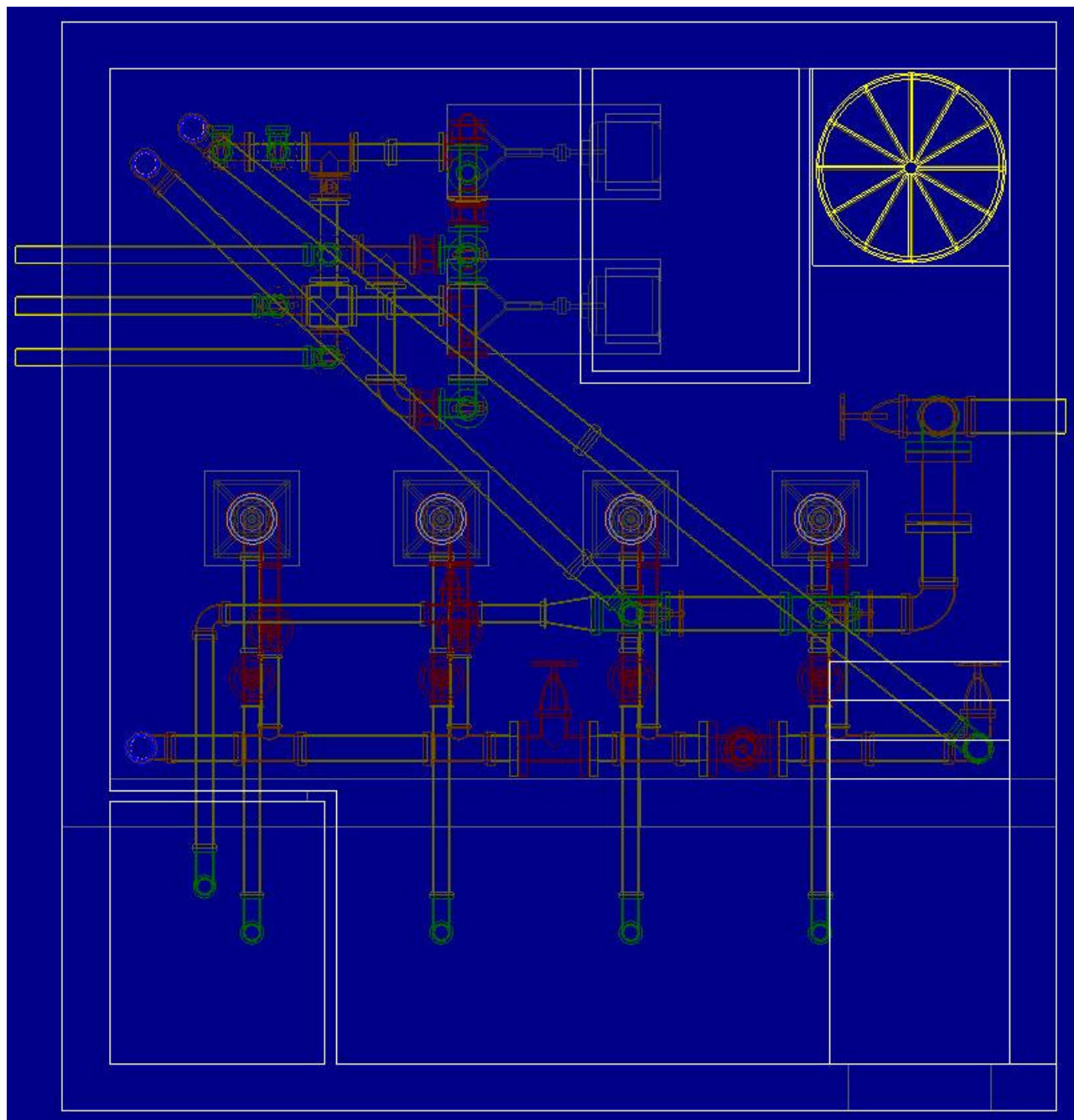


Figure 2. ProEngineer model





Figure 3. Photograph of components in the facility

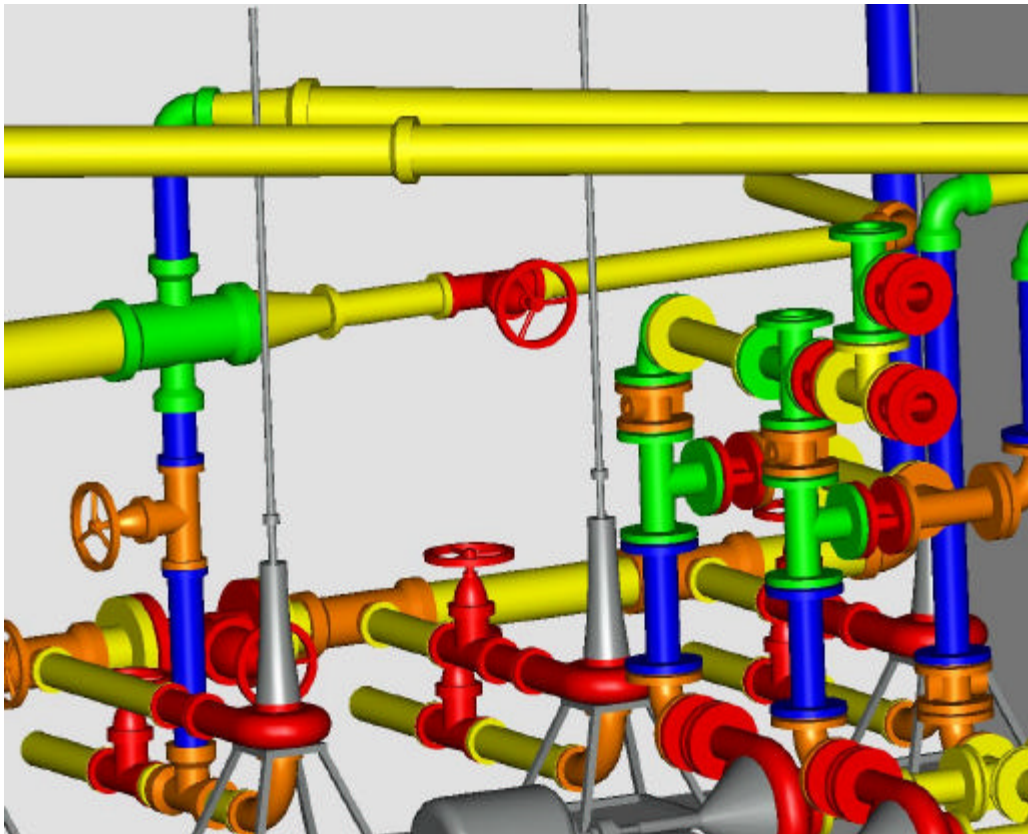


Figure 4. ProEngineer model of photograph

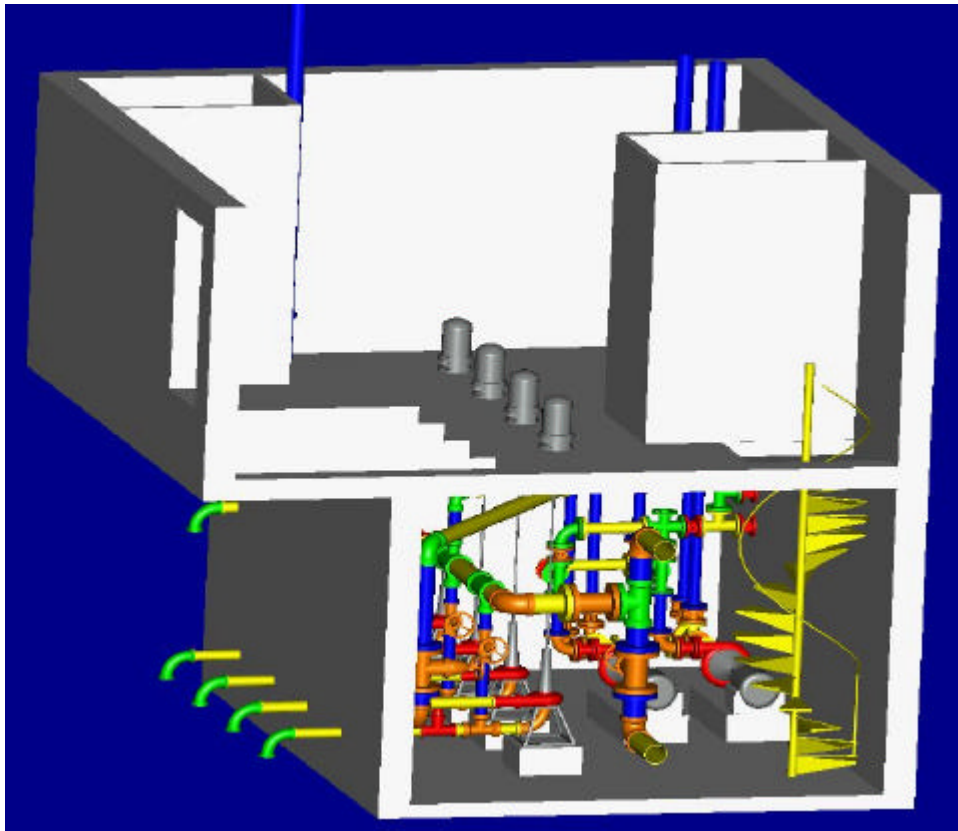


Figure 5. ProEngineer facility model

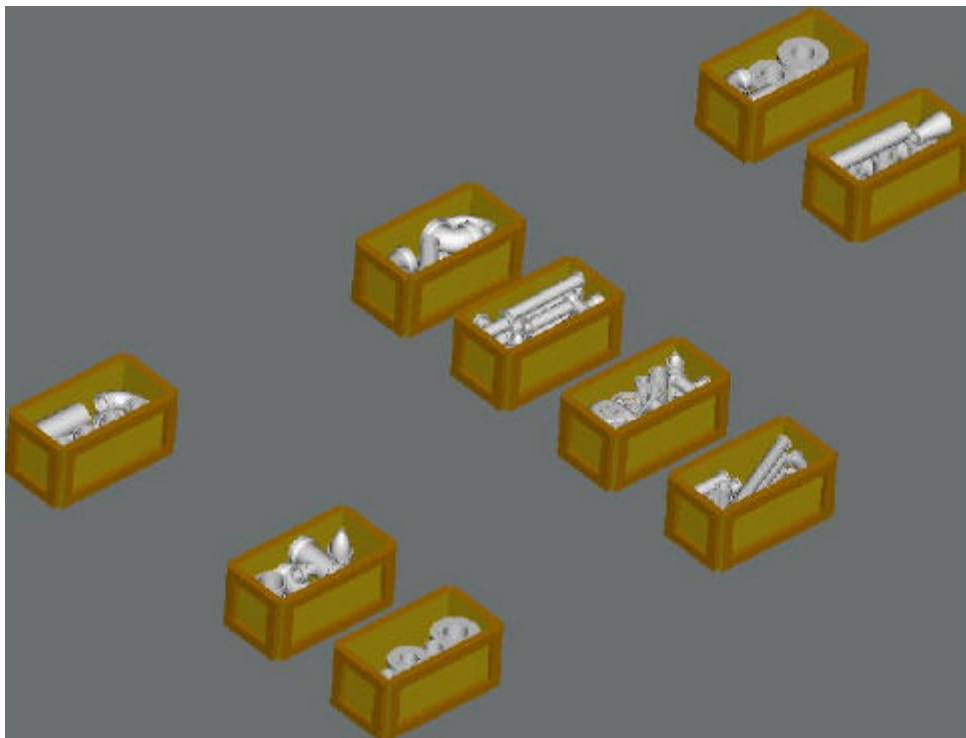


Figure 6.